# Development of a Portable Information System: Connecting Palmtop Computers with Medical Records Systems and Clinical Reference Resources

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## ABSTRACT

*The portability of palmtop computers makes them an ideal platform to maintain communication between busy physicians and medical information systems.. In our academic FHC (Family Health Center) we have developed software that runs on a palmtop computer allowing access to information in the HIS (Hospital Information System) and our FHC's AAMRS (Automated Ambulatory Medical Record System). The resident physicians who staff the hospital and the FHC are frequently at home or otherwise off-site where terminal access is not available.*

*Using a Hewlett-Packard 95LX palmtop computer as the base platform, custom software has been developed to access summary data on in-patients and out-patients. Data is downloaded into a database on a palmtop computer memory card. ASCII data from Medical Information Systems (MIS), is transformed into a database format readable on the palmtop. Our hospital MIS department transmits information daily on our in-patient service (20-30 patients). We also download, weekly, a patient summary on all of our active out-patients in our MUMPS-based AAMRS (2500-3000 patients). Each morning the resident in the Family Practice program updates his palmtop memory card at a central workstation.*

*Palmtop computers with downloaded databases, can be valuable in care of patients when the physical or on-line chart is not easily accessible. They are particularly useful in multi-physician groups when the on-call physician provides care for the patients of other physicians. We have made the palmtop computer even more valuable to physicians by providing an integrated software package. This package includes information management software with to-do lists, reference software such as drug formularies, and decision support software.*

*The downloading of patient information creates two important problems: security and reliability. To assure the confidentiality of downloaded patient information, the palmtop system uses password protection. Since the data is only periodically downloaded, it will not always be current. Further evaluation will be needed to determine if the frequency of downloads is adequate.*

*Now that a portable clinical information system has been designed, further study of physician use has begun. Future integration of messaging and wireless communication technologies, pen and voice entry will make palmtop computing even more relevant to clinical care.*

## INTRODUCTION

Advances in electronics have allowed miniaturization of powerful computers to pocket-size. These pocket-size computers are known as palmtops and can store large amounts of data. The size of palmtops allows them to be carried by physicians continuously when on-duty. Palmtops containing databases downloaded from HIS and AAMRS can be valuable in the care of patients when the paper or on-line chart is not easily accessible.

Our academic FHC has had an AAMRS in use for the past 7 years. It includes dictated patient visits and summary data on active diagnoses, medications, allergies, immunizations, and health surveillance items. Approximately 30 different physicians (residents and faculty) see patients at the FHC on a part-time basis. These physicians also staff the hospital and share call, covering patients for the other physicians on weekends and nights. Problems that occur during these off-hours require the on-call doctor to have some information regarding the patients. Traditionally this information has been communicated during group physician meetings and with handwritten notes passed along to the on-call doctor. Resident physicians feel that this complicated and inefficient sign-out process needs to be improved [1]. A palmtop computer containing detailed summary information and comments on patients could be carried by the on-call resident instead of hastily scribbled notes.

Recent attention has been paid to the use of the palmtop computer to replace the "peripheral brain" and index cards summarizing patient information frequently used by many physicians [2]. The palmtop is a good method of

organizing clinical "pearls" of information gathered during the training years [3].

## INFORMATION COMPONENTS

Our portable information system integrates data from the HIS, AAMRS, and decision support references The Current Patient Profile summary document from the HIS and a Patient Status Report from the AAMRS provide diagnostic and treatment data on active patients. Decision support resources from databases on drug information, on optimum antibiotic choices, and a medical care pocket guide have also been included. Other databases contain administrative information such as frequently-needed phone numbers, ICD codes, beeper numbers and schedules . A procedure documentation database allows residents a simple way to record clinical experiences.

Placing all this information on the palmtop computer has advantages beyond portability. It allows the user to have a single consistent interface for accessing all the databases on the computer. The data from various sources can be integrated to reduce the need for redundant entries. Medications on a patient summary can be linked directly to the drug information database without reentry or closing and reopening programs.

Having the data on a separate computer protects the integrity of the central database and avoids conflicts with MIS managers. Additional data components can be developed for the palmtop user which would not be desirable on the originating system. This gain in flexibility allows the focus to be placed on the clinician using the information. The system is optimized for the clinician's needs.

## METHODS

A Hewlett-Packard 95LX [4] palmtop computer was chosen due to size, cost, memory, and DOS-compatibility. Custom software was designed using the Clipper [5] development package to allow access to data in DBASE 3 [6] format on the palmtop computer. Clipper was chosen because of its compiler capabilities to create stand-alone executable code that can be directly moved to the palmtop. Clipper also allows for the control of the smaller video display on the palmtop.

Data from our TDS [7] hospital system, and our MUMPS-based AAMRS [8] is downloaded in standard text format to a desktop personal computer. Little if any support is needed from the operators of the originating system. The text comes from standard reports created for patient information summaries which

are already being utilized in the Hospital and FHC. Using software designed in Clipper, this text data is then extracted, parsed and transformed into the DBASE 3 format usable on the palmtop computer. Extracting and parsing the data is done by "finding" the major headings with string searching, then capturing the various important information segments. This otherwise tedious process is performed by software that requires a fast central workstation linked to the HIS and AAMRS. Data from the HIS is updated automatically on a daily basis. Data from the AAMRS from the FHC is updated on a weekly basis and requires some operator effort to download the information.

The database computer files are then copied onto large-capacity (20MB) memory cards via a memory card drive (similar to a floppy drive) on the central workstation. These credit card-sized memory cards comply with PCMCIA (Personal Computer Memory Card International Association) standard and are usable with the palmtop computer system. The 95LX palmtop, a memory card and the latest advance a modem on a PCMCIA card are shown in Figure 1.

The custom-designed palmtop software is menu-driven for simple use; little training is required. Extensive indexing is done to access the data quickly, so that response times are rapid. Examples of the menu screens are shown in figure 2. The software is optimized for clinical task-oriented data retrieval. An example of this type of data retrival is reviewing medication information from within a screen displaying an in-patient summary.

## UTILITY OF IMPROVED ACCESS

A palmtop computer is available to the resident in our Family Practice residency program to access the data on current in-patients and active out-patients from the FHC. The patient information includes demographics, major diagnoses, current medications, allergies, code status, and consults. This information is otherwise unavailable unless the resident is located at a special computer workstation.

The palmtop computer system allows physicians to add new information to the palmtop database, such as to-do lists and comments. The palmtop can then track this information and "remind" the physician, allowing the computer to be a patient information management system. This replaces the inefficient index cards which most residents now use.

The following are two examples of uses for the physician while on-call: (1) Reviewing

**Figure 1. The palmtop computer, modem card, cable and memory card.**

SHADYSIDE HOSP FAMILY PRACTICE
4/5/93                                        8:30am
Main Menu
1. Out Patient menu
2. In Patient Menu
3. OB Patient information
4. Antibiotic Choices for pathogens
5. Hospital Formulary
6. Look-up ICD Codes
7. Physician Directory
8. Drug Store Phone numbers
9. Reference Manual

0. End Program

ENTER OPTION *

**Figure 2a. The Main Menu Screen on the Palmtop**

SHADYSIDE HOSP FAMILY PRACTICE
4/5/93                                        9:00am
Out Patient Menu
1. View Patient Summary
2. Modify Patient Summary Information
3. Add New Patient to Database
4. Delete In-Active Patient from Database
5. Review To-Do List for Patients
6. Review Follow-up Data for Patients
7. Review Office Hour Schedules
8. Review Guidelines For Health Maint

0. Return to Main Menu

ENTER OPTION *

**Figure 2b. The Out-Pt Menu Screen on the Palmtop**

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pre-natal records and labs from the FHC when the patient is admitted in labor prematurely. Physical copies of these records have not been sent yet because the lady is premature. If this data were not accessible much of the labwork would need to be repeated, and may not be available at the time of delivery. (2) Reviewing the current medication list from the FHC when a colleagues patient is admitted through the emergency room. Frequently the patient is unable to remember medication names or dosages.

## INHERENT LIMITATIONS

Using a palmtop computer and a redundant database poses limitations. There will be a time delay for information from the originating data source to appear on the palmtop computer. In some instances the delay can be critical and other methods of obtaining the data will still be needed. Data security needs to be assured so that casual users of the palmtop cannot peruse confidential patient data. Inherent to the palmtop system is the probability of loss, damage, and theft. While the palmtop computers are powerful, the main-frame and mini-computers used by the HIS and AAMRS allow sophisticated capabilities that the palmtop will always lack. These limitations are important, and need to be closely evaluated before palmtops are to gain widespread acceptance.

## FUTURE

Now that a portable clinical information system has been designed, study of the impact on physician activities is underway in our program. We are using electronic tracking, which is built into the software, to study the frequency of use of each module. Physician responses to palmtop use will also be elicited.

Palmtops will soon gain improved communication capabilities that will increase their usefulness. They will feature cellular phone and beeper messaging capabilities. Wireless connection to local and wide area networks will also be possible. The user interface will continue to improve with the options of pen and voice entry. Continued improvements in the palmtop electronics will allow more graphics, making a more user-friendly interface.

These potential advances will make mobile computing a necessity for good clinical care. Introduction of these valuable medical informatics tools to physicians in training is critical.

## REFERENCES:

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